



A Common Sense Approach to Project Management

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Topics

Space Science and
Engineering
Division

Project Management

- ◆ **Description of paper**
- ◆ **What counts, what doesn't, in managing for mission success**
- ◆ **It's the schedule stupid!**
- ◆ **Earned value really helps!**
- ◆ **Risk management, love it or leave it**
- ◆ **Summary**



Description of Paper

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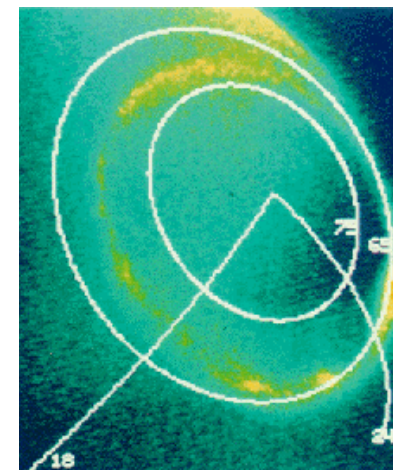
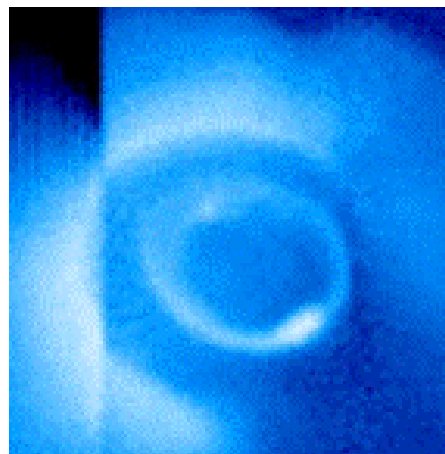
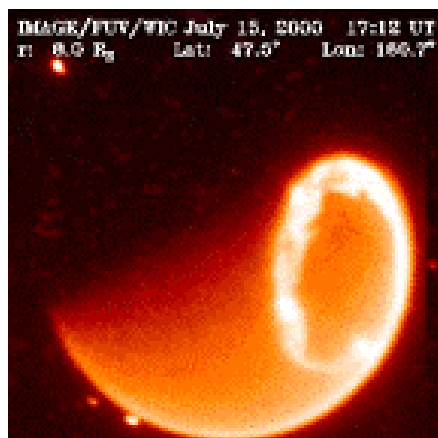
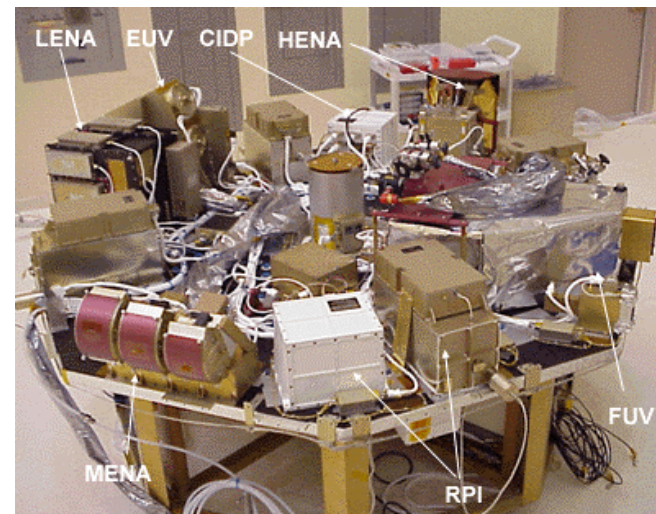
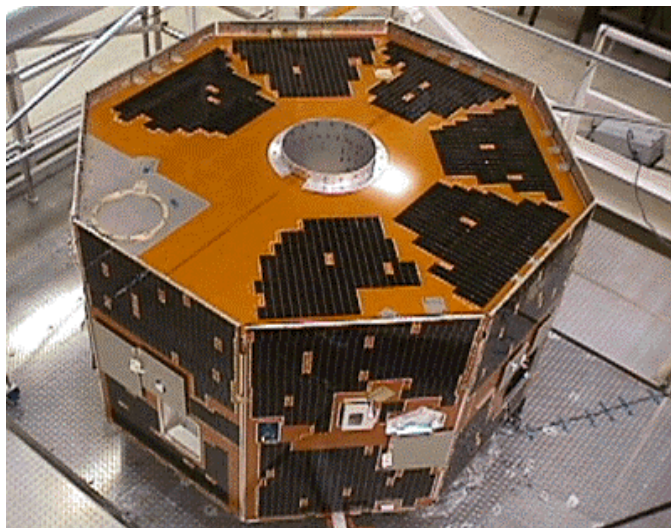
- ◆ **Based on real-world experiences of a manager of NASA missions, plus..**
 - Experience in serving on >12 mission review panels in the last 5 years, and
 - Experiences gained in developing C&DH systems for >40 mission going back to the days of Spacelab, and
 - 35 years experience in developing instrument, support systems, payloads and missions
- ◆ **This is not a paper for academics, it's for working PMs**
 - No attempt to develop any new first principles of management
 - MBAs may want to find something else to do while this paper is presented
 - The vast majority of problems facing PMs can be identified, characterized , quantified and FIXED using simple tools and good common sense
 - If you think you need a 1% accurate metric to manage a problem, you're probably on the wrong track
 - Will discuss techniques for avoiding trouble in the first place



IMAGE, the First MIDEX Mission

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Things that Matter and Help

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◆ Schedule

- Managing the schedule matters more than anything else you will do as a PM
- You have no hope of controlling cost if you can't manage the schedule
- Longer schedule does NOT mean easier or cheaper

◆ Earned Value

- Earned value management works!
- The best early-warning system around
- A simple earned value system can be implemented with inexpensive tools

◆ Requirements Management

- Unstable, or changing requirements are absolutely death to a project
- Don't fall for the old "gee, for 10% more resources I can double the science"
- Document requirements (science requirements, mission requirements, instrument requirements in detail in Phase A)

◆ Technology Readiness (TRL)

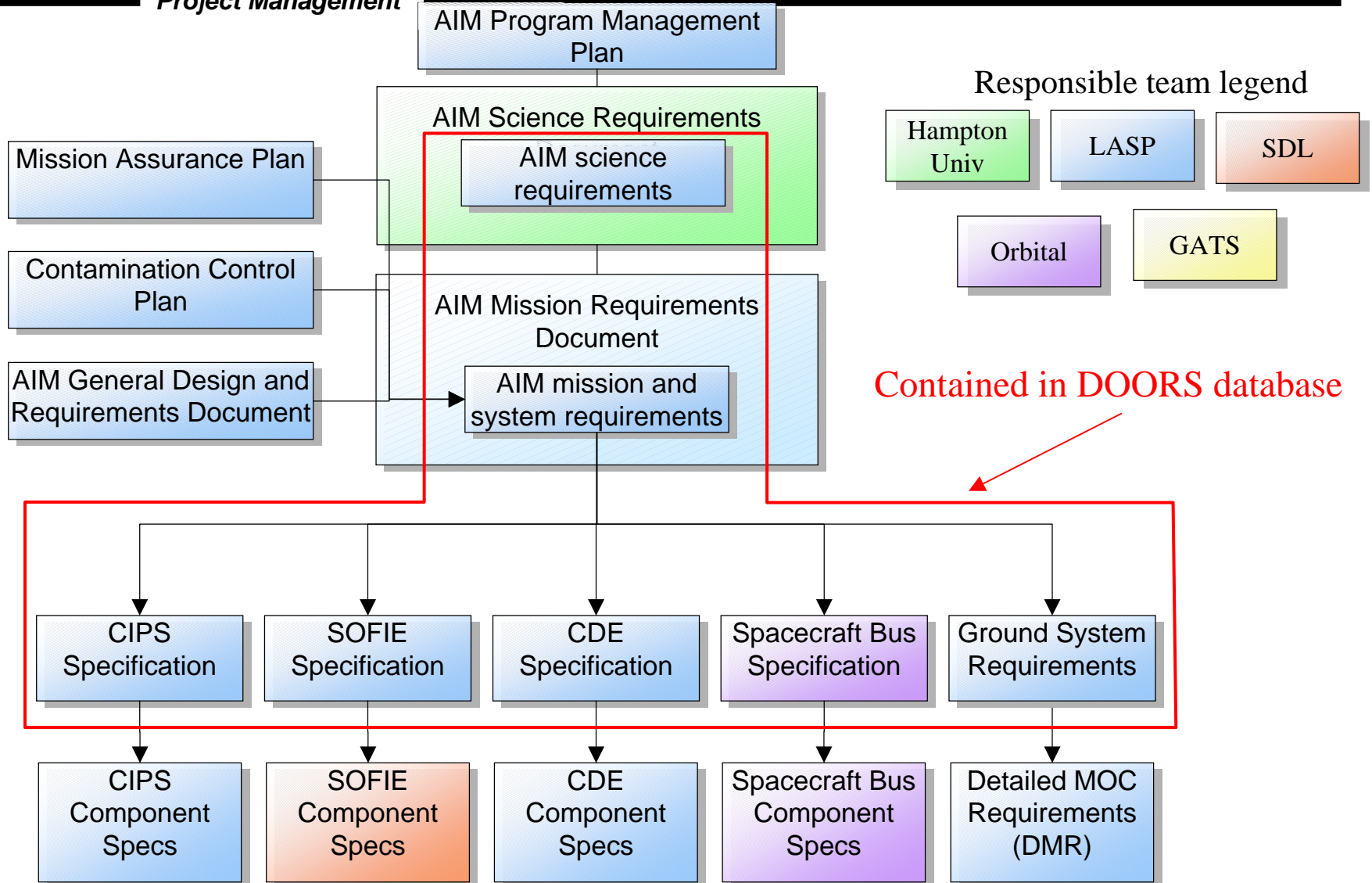
- Space science missions are almost always under funded and there is no way to develop new technology on a resource-capped mission
- Avoid (minimize?) oversell in the proposal stage, remember, you are going to have to live with your exaggerations in Phase B, C/D and E



Requirements Flow Down Example from the AIM Mission

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Things that Matter and Help (2)

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◆ Systems Engineering

■ Interface Control

- ICD make ALL the difference in controlling risks with interfaces
- Early draft ICDs are better than late, perfect ICDs
- Test interfaces as early as humanly possible, DO NOT wait for flight hardware and software to be completed
- Have the group responsible for the interface develop the interface simulator
- Define interfaces completely but avoid the tendency to put too much detail in your ICDs or you will never finish them

■ Resource Allocation and Tracking

- Allocate resources during the Phase A proposal, before money gets involved
- Start tracking resource trends in Phase A
- Links resource trends to descope options

■ Trade Studies

- Perform as many trade studies as you can during your Phase A proposal preparation
- Finish as many trades as possible in Phase A, otherwise your cost estimates at confirmation are likely to be wrong



Things that Matter and Help (3)

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◆ Risk Management

- Risks spotted early can be attacked and retired
- Recording and tracking risks systematically helps
- Quantifying risks (NASA's 5 x 5 matrix) can help prioritizing resources needed to mitigate risks
- The Continuous Risk Management process actually works, but it can be hard to keep up and it's tempting to let risk status slip in the heat of battle

◆ Peer reviews

- Table top, engineer to engineer, peer reviews are the best way to spot design problems early
- Much more useful in spotting problems than formal milestone (PCD, CDR) reviews
- Review board members must be practicing engineers in the discipline under review
- Minimize vugraphs, maximize drawings, VHDL code listings, schematics, parts lists, software listings and other design and analysis products
- Keep records of action items, follow through with responses to actions



Things that Matter and Help (4)

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◆ Timely Decision Making

- Essential to make decision in a timely manner to avoid loss of momentum
- In many (most?) cases, a bad decision is better than decision since a bad decision will be obvious soon enough and can be corrected

◆ Open, cooperative relationship with NASA

- Avoid turning issues into “who’s in charge”
- Accept help when offered!

◆ Trending

- Trending resources as early as Phase A is vital to instilling in the team the value of resource management
- Trend mass, power, and schedule performance at a minimum
- Trends are usually a good indicator of a team’s performance

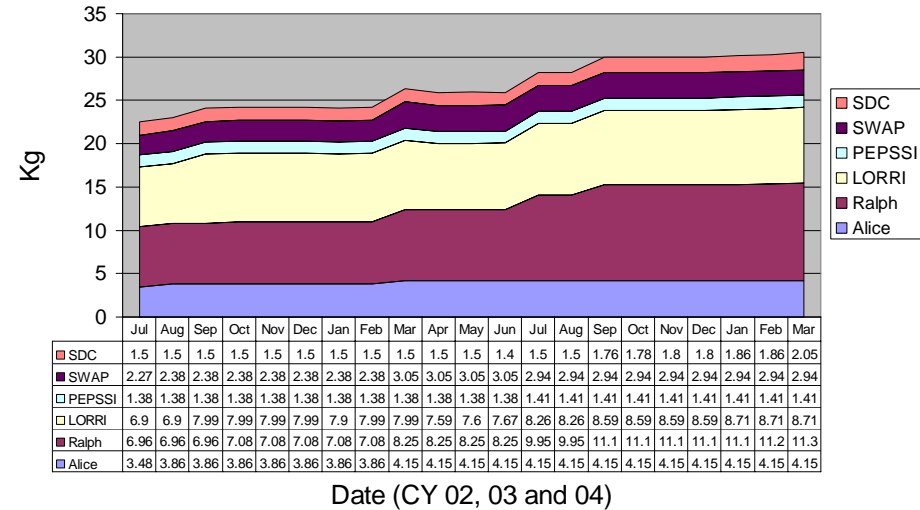
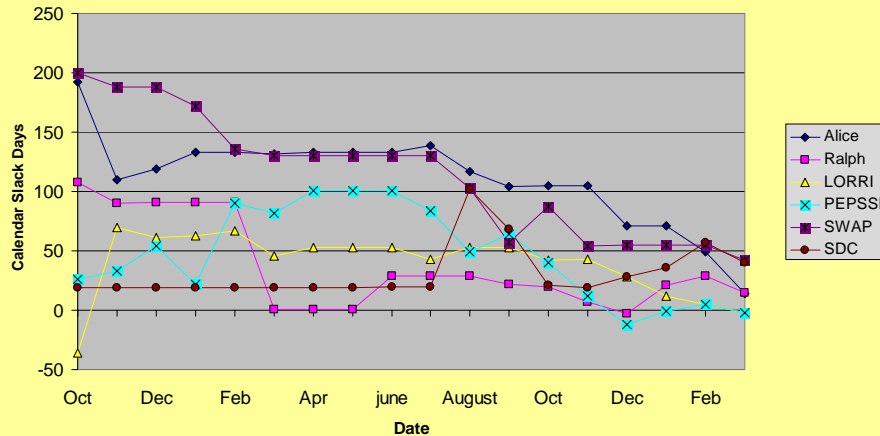


Examples of Useful Trend Charts

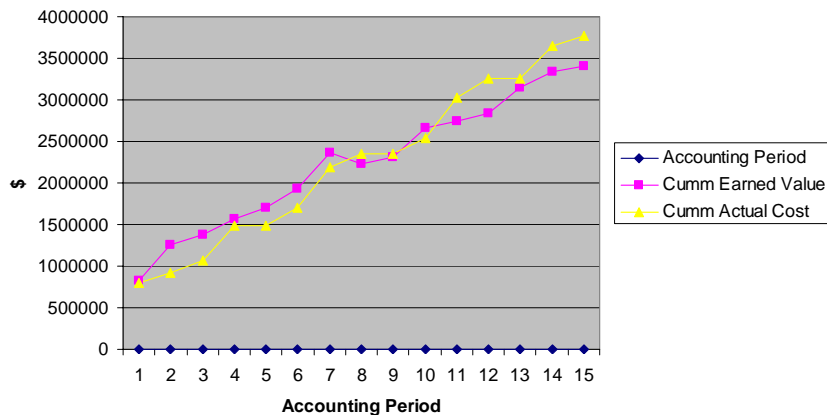
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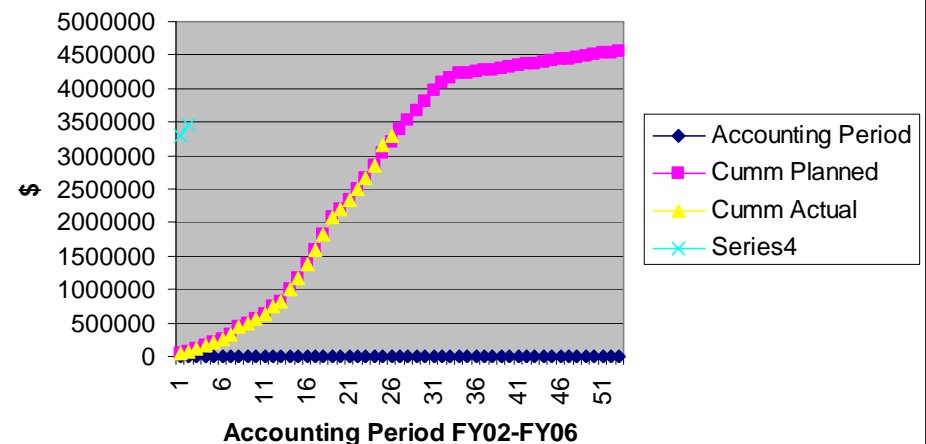
NH Payload Slack Summary Chart



SWAP Earned Value vs. Actual Cost



SWAP Planned/Actual Costs



3/30-31/2004

NASA Project Management Conference

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Things that Don't Help

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◆ Complex, overly-accurate performance metrics

- No matter how sophisticated your performance metrics, at the end of the day they will not fix anything
- If your earned value process gives you cost variance numbers that are accurate to within $\pm 20\%$, that's good enough to alert you to a problem
- Don't become a slave to your metrics, they are no substitute for common sense and quick corrective action
- Timeliness is of more use than absolute accuracy

◆ Meetings/telecons with no particular purpose

- Project teams commonly schedule team meetings and telecons for the purpose of exchanging important information
- Many times meetings and telecons exceed their value and continue too late in the project
 - Don't try to fill the dead air time, just dismiss the meeting and get back to work
 - Recognize when you have hit the point of diminishing returns



Things that Don't Help (2)

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◆ ISO-based quality management audits

- The current AS9100 based quality management system based audit process is not working very well and is causing hard feelings
- The “one size fits all” approach to the auditing process is not helpful

◆ Discontinuities/delays in funding

- This is a major, and frequent, problem for institutions serving as a mission principal investigator institutions
- This can happen at either the start of a project or at major mission phases (e.g. confirmation)
- This problem appears to be getting worse

◆ Developing new technologies on flight projects

- Wrong place to be developing technologies
- Cost and schedule capped missions do not have the resources to develop new technologies

◆ The latest FPGAs!



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Thoughts about ITA Applied to Cost Cap Missions?

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“If you hang them all, you’re sure to
get the guilty ones”



Judge Roy Bean

“The law west of
the Pecos”



It's the Schedule Stupid

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- ◆ **Schedule management is absolutely critical to project success**
 - Schedule needs to be developed in detail in Phase A to be of maximum use
 - Has to be based on a complete, mission level, work breakdown structure (WBS)
 - Equipment developers must develop and maintain their own schedule using a WBS provided by the PM
 - Schedule ownership is critical
- ◆ **Team must know by the words and the deeds of the PM that slipping schedule is unacceptable, from the first day of the project**
- ◆ **“Attack” the schedule, complete work early and put the reserves gained in the bank for use during integration and test, when the most serious problems arise**
- ◆ **Developers must update their schedules monthly and the PMs team should integrate all the schedules into a mission master schedule**
 - Mission schedule links instruments, payload, spacecraft, ground segment and I&T into one schedule
 - Facilitates mission level “what if” trades



It's the Schedule Stupid (2)

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◆ Invest in a good scheduling tool and in the training to use the tool properly

- MS Project and Primavera Project Planner (P3) are popular and well supported
- If at all possible, resource load your schedules using the people you plan to use on the project
- Resource leveling is a great way to see if your schedule will be driven by the lack of a specific resource
- Include institutional holidays in your schedule
- A good scheduling tool can be used for developing and tracking cost and for producing earned value reports
 - Complication for many institutions is that the institutional accounting system does not have the ability to track costs against the WBS below level 1
 - Consider using a simple system of assigning a value to a set of tasks or milestone in the schedule and earning value based on the completion of the group of tasks
 - Hammock tasks can be used to straddle WBS elements and can thus be used to approximate earned value of the tasks within the WBS
 - Load all resources need for the WBS into the Hammock task
 - As the schedule stretches, the value of the work performed will adjust accordingly



Earned Value Really Works

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- ◆ **Even a simple earned value system will provide warnings of cost or schedule problems ahead**
 - Time-phased spend plans are only accurate the day they are generated and do not automatically adjust with changes to the schedule
 - Spotting cost problems early provides the PM with the maximum time possible to take corrective action before the problem impacts cost or schedule reserves
- ◆ **The best EV system is built from a resource loaded schedule**
 - Provides a budget for every task or for a group of tasks
 - Institutional accounting system needs to be able to accrue costs to the same level of the WBS for which earned value is calculated
 - If this is not possible, then allocation budgets from the top down for a group of tasks (WBS element) can be used
 - Earned value is accrued based on completing the tasks and the earned value is compared to the actual cost for the total project to date
 - Entering actual costs into the scheduling tool enables an accurate calculation of the value of work performed (earned value), budgeted cost of work scheduled, cost variance, estimate to complete and estimate at completion



Risk Management

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- ◆ **Continuous risk management (CRM) is not only a good idea, it's also a contract requirement**
- ◆ **NASA's NPG 8000.4 provides a good set of guidelines**
- ◆ **CRM works best when all project team members, including subcontracts, participate in the process of identifying risks early, quantifying risks, developing plans for avoiding or mitigating risks, and tracking the status of risks**
 - **Every risk has to have an associated risk mitigation plan and a trigger date or trigger criteria which is used used to activate the risk mitigation plan**
 - **Monthly risk status needs to be recorded and tracked**
 - **Recognize that problems are not the same as risks, problems are risks that have escaped mitigation**



Risk Management (2)

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- ◆ **Multiple web-based tools are available to use in implementing a CRM process**
 - GSFC's PRIMX
 - SwRI's Risk Management System
 - Both allow users to enter a description of the risk, quantify the risk using likelihood and consequence parameters, rank order the missions risks, and associate a mitigation plan and trigger date with each risk
- ◆ **Implementing a comprehensive reliability engineering process early in the design phase is an excellent risk reduction process**
 - Starting with board or box level reliability calculations based on MIL-STD-217 parts count method
 - Building from the board or box reliability calculations to a reliability block diagram and upwards to fault tree analysis and probabilistic risk assessment to quantify reliability
 - Sensitivity analyses can be used by the designers and systems engineers to determine where an investment can be made in redundancy or improved parts to realize the maximum improvement in reliability
 - Even a single string system can be improved with this process



Conclusions

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- ◆ **Managing for mission success requires an aggressive, no-prisoners, schedule management process and mindset for project leadership**
- ◆ **The earned value metric is an excellent indicator of cost problems yet to come**
- ◆ **Good practices with schedule management, EVM, peer reviews, systems engineering and requirements management will maximize your chances of success**
- ◆ **Flight projects are NOT where new technology should be developed**
- ◆ **Risk management is a process that's worth the trouble to implement and manage but all team members must participate for it to work**